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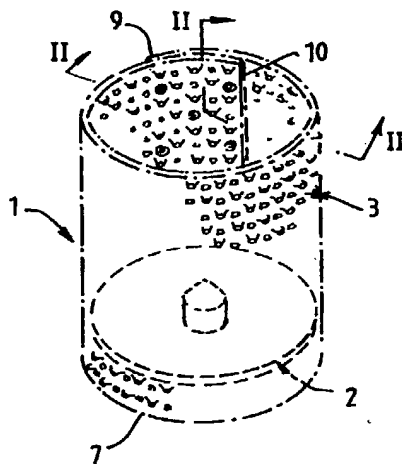
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(21) International Application Number: PCT/AU98/00804 (22) International Filing Date: 24 September 1998 (24.09.98) (30) Priority Data: PO 9385 24 September 1997 (24.09.97) AU (71) Applicant (for all designated States except US): R & R OWEN NOMINEES PTY. LTD. [AU/AU]; Main Road, Harrietteville, VIC 3741 (AU). (72) Inventor; and (75) Inventor/Applicant (for US only): LAWTON, Peter, Alan [AU/AU]; 92 Beaumont Road, Berwick, VIC 3806 (AU). (74) Agent: CARTER SMITH & BEADLE; 2 Railway Parade, P.O. Box 557, Camberwell, VIC 3124 (AU).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>

(54) Title: PLANT GROWTH CONTAINER AND METHOD OF MAKING SAME**(57) Abstract**

A plant growth container (1) has its side wall (3) formed from at least one sheet of flexible material having opposite first and second edge portions (9, 10), an inner surface and an outer surface, said inner surface having a lattice of root guiding recesses formed therein, at least some of said recesses being of substantially truncated conical form terminating in an opening through the sheet, said outer surface having a lattice of protuberances at the same relative positional arrangement as the recesses, said sheet being arranged with a first edge portion overlapping either an opposite, second edge portion of the same sheet or a second edge portion of another similar sheet, with the protuberances of the outer surface of the second edge portion nesting within the recesses on the inner surface of said first edge portion to align openings in the protuberances at the overlap and wherein at least one screw threaded fastener having a threaded shank and an enlarged head at one end of that shank is located within the aligned openings to secure the overlapping edge portions together.

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PLANT GROWTH CONTAINER AND METHOD OF MAKING SAME

FIELD AND BACKGROUND OF THE INVENTION

5 This invention relates to containers for storing growing plants and it also relates to a method and apparatus for making such containers. The invention is particularly concerned with above ground storage of growing plants which are intended for eventual transfer to the ground.

 The word "plant" as used throughout this specification is to be understood as
10 embracing all forms of plant life, including shrubs, bushes and trees, having a root structure which extends at least during the early stages of growth of the plant. Furthermore, the invention will be hereinafter described with particular reference to plants being grown in a growing medium, but the invention is not limited to such circumstances. By way of example, a container according to the invention might be usefully adopted in the application of gravel
15 hydroponics.

 A container for the root ball of a growing plant is the subject of Australian patent No.629067. A particular feature of that container is the side wall arrangement which promotes air pruning of the expanding root structure. The arrangement is such that laterally extending roots are directed towards openings of restricted size formed through the container
20 side walls. The wall material is generally formed from cusped plastic sheet material with protrusions of generally conical shaped protrusions extending from the outer surface. The root growth which extends to the openings is air pruned in a known manner, thus causing secondary roots to form. The same growth and air pruning process is repeated with the secondary roots. The root system thus obtained, forms a well matted and cohesive root ball
25 which is ideal for transplantation.

 The container of preferred embodiments of Australian patent 629067 suffers from the disadvantage of not having a base. The container is in effect a tubular member formed of a flexible panel, the upright edges of which are secured together to retain the tubular form of the container. It is a feature of these containers that the diameter may be increased as the
30 plant grows. Accordingly, bases are not feasible with such containers. A problem with that container, and other containers which do not have a base, is that it is difficult to transport the container from one place to another while soil and/or a plant remain within the container.

A further problem with the containers of Australian patent 629067, and similar containers, is that there is no control of downward root extension comparable to the control imposed on lateral root extension. It is therefore generally necessary to locate the container on a surface which cannot be penetrated by downwardly extending roots, or to otherwise
5 guard against uncontrolled downward extension of the root structure into the underlying soil or gravel. Downward root extension tends to reduce lateral root growth.

Australian patent application 51865/93 (674543) is concerned with a container of the general kind disclosed by Australian patent 629067, but which is provided with a base. Various base constructions are described in the specification of application 51865/93, but in
10 practice the only generally acceptable base is one formed of an imperforate plate of sheet metal. That form of base has two serious drawbacks. One is the absence of air pruning for downwardly extending root growth, and the other is the relatively short useful life of the base as compared with the useful life of the container body or side wall. It has been found that the average lifespan of the side wall is ten uses of approximately six months each, whereas the
15 base is usually needs to be discarded after two uses, each lasting approximately six months.

Containers of the kind to which patent application 51865/93 and Australian patent 629067 are directed, are intended for above ground use. That is, the container with a plant in place is stored on the ground or another surface rather than being embedded into the ground. A serious difficulty encountered with such an arrangement is the possibility of the container
20 toppling over in transit from one place to another, or as a consequence of exposure to wind of moderate to high strength. Toppling of the container can cause damage to the plant and increases the difficulty of maintaining the condition of stored plants and the environment in which they grow.

Furthermore, containers of the foregoing kind have not been sufficiently robust to
25 withstand the rigors of use to which they are subjected. The container side wall is made of a sheet of material which is arranged to form a cylinder, and overlapping edge portions of the sheet are secured together to retain that cylindrical form. The side wall material is relatively flimsy and prior methods used to hold the overlapping edges of that wall against separation have not been entirely satisfactory. In practice when a base is used with these containers it is
30 not uncommon for the base to separate from the side wall because of the lack of overall rigidity in the structure.

Australian patent 629067 mentions the possibility of using rivets as side wall

fasteners, but these are not releasable other than by cutting the rivet and rendering them non reusable. This lack of releasability precludes the adjustment of the diameter as the container is expanded, or the container being re-used. Known types of releasable fasteners such as clips, straps or ties have not provided a reliable, secure fastening for such containers. It is, therefore, desirable to provide a releasable fastening that is more convenient and effective than those previously proposed.

Yet another difficulty exists in the manufacture of the sheet material from which the side wall is formed. That material, which is generally referred to as cuspat material, is imperforate in the as-manufactured condition. That is, it does not possess the openings which are necessary for the side wall to enable air pruning of plant roots. Those openings must be formed by a subsequently applied process, and the methods so far adopted for that purpose are not readily adaptable to efficient automation and do not produce an opening of sufficiently precise size or shape.

It is therefore desirable to provide a plant growth container of the foregoing kind which is of relatively robust construction. It is also desirable to provide such a container having an improved base structure. It is further desirable to provide an improved method of forming such a container. Yet another desirable feature is to provide an improved method and apparatus for perforating the material intended to be used for the side wall of such a container.

The side wall of a container according to the invention may be formed of a single sheet of material having overlapping opposite edge portions secured together to create a wall of substantially cylindrical shape. Two or more sheets of material with overlapping adjacent edges could also be used to form the side wall, but the invention will be hereinafter described in relation to a container formed from a single sheet. As will be explained later, in some embodiments of the present invention two or more sheets are preferred to be used as the side wall.

The sheets of side wall material may be manufactured via a moulding process or an extrusion process. This latter process produces continuous sheet. The moulding manufacturing process leads to sheet material that has very consistently positioned protrusions or cusps. In containers that have bases that are located between annular protrusions from the side wall, the consistency of the position of the protrusions is very important to enable proper fit of the base. The continuous sheet extrusion process tends to

lead to variations in the positioning of the protrusions. A variation of more than $\pm 1\%$ may lead to difficulties in the secure fitment of the base. If the protrusions are closer than desired the base needs to be reduced in diameter to allow the attachment of the overlapping portions of the side walls. If the protrusions are further apart than specified the base is not as securely
5 retained and under load conditions may detach from the bottom of the pot. The moulding process which does not suffer from the above discussed variation in protrusion positioning is generally more expensive than the extrusion process.

SUMMARY OF INVENTION

10 According to one aspect of the invention there is provided a plant growth container including at least one sheet of flexible material having opposite first and second edge portions, an inner surface and an outer surface, said inner surface having a lattice of root guiding recesses formed therein, at least some of said recesses being of substantially truncated conical form terminating in an opening through the sheet, said outer surface having
15 a lattice of protuberances at the same relative positional arrangement as the recesses, said sheet being arranged with a first edge portion overlapping either an opposite, second edge portion of the same sheet or a second edge portion of another similar sheet with the protuberances of the outer surface of the second edge portion nesting within the recesses on the inner surface of said first edge portion overlapping either an opposite, second edge
20 portion of the same sheet or a second edge portion of another similar sheet, with the protuberances of the outer surface of the second edge portion nesting with the recesses on the inner surface of said first portion to align openings in the protuberances at the overlap and wherein at least one screw threaded fastener having a threaded shank and an enlarged head at one end of that shank is located within the aligned openings to secure the overlapping edge
25 portions together.

Preferably a space exists between the head and the thread convolution closest to the head. That space may be created by terminating the thread formation just short of the head so that an unthreaded portion of the shank exists immediately adjacent the head. A commercially available fastener of that kind is the Wallmate (trademark) fastener
30 manufactured by ITW New Zealand Ltd., a subsidiary of Illinois Tool Works Inc.

In a further aspect of the invention the upper end of the container side wall may be strengthened by a ring of material located on the inside of the wall in a circumferential recess

formed between two adjacent rows of inwardly directed cusps.

Preferably the ring is formed of a tubular material which may be a plastic tubular material of the kind used in irrigation systems. With such an arrangement the tubular ring may have an inlet for introducing water into the ring, and one or more outlets through which
5 the water is delivered to the plant in the container.

In a still further aspect of the invention the container includes a base and wherein that the container base is formed of a perforated material adapted to promote air pruning of downwardly extending roots and wherein the base is adapted to be retained between two rows of inwardly protruding cusps in the container.

10 Preferably the base is constructed so as to be engageable with a support surface such as the ground, and wherein that engagement is provided by an annular foot portion of the base which is located adjacent the container side wall.

Preferably the foot portion is connected to the body of the base through a web having openings therethrough to permit air to flow through the space between the body of the base
15 and the container supporting surface.

Preferably the base is adapted to provide flood and drain watering as well as capillary watering.

According to another aspect of the invention there is provided a method of forming openings in the cusped material intended to form the side wall of a
20 plant growth container characterised in that the openings are formed in the sheet material by a punching process which involves punching successive groups of openings in sequence by feeding the sheet material to be punched through a punching station in step wise fashion such that a respective group of openings is formed each time the material pauses at the punching station.

25 Preferably each group of openings is formed by a series of punches and the punches within that series are relatively arranged so that not all openings of the group of openings are formed at the same time.

By way of example, some punches in the series may trail behind others so that they strike the sheet material after the other punches have penetrated through that material. In one
30 arrangement, the punches may be relatively arranged so that only a single punch, or a small number of punches, penetrates the sheet material at any one point in time.

Preferably the side walls of the container comprise two or more sheets of material.

These, and other aspects of the invention will now be described in greater detail by reference to the accompanying drawings.

5 BRIEF DESCRIPTION OF THE DRAWINGS

- Figure 1 is a perspective view of a plant growth container;
Figure 2 is a section on the line II - II of Figure 1;
Figure 3 is an enlarged view of part of the side wall of the container of Figure 1;
Figure 4 is a section on the line IV - IV of Figure 3;
10 Figure 5 is an enlarged view of the screw threaded fastener shown in Figures 3 and 4;
Figure 6 is a view of an upper part of the side wall of the container;
Figure 7 is a plan view of part of the base of the container;
Figure 8 is a section through a modified base for the container;
Figure 9 is a section through another base for the container;
15 Figure 10 is a section through a further base for the container; and
Figures 11 to 14 are diagrammatic illustrations of preferred methods and apparatus for constructing the side wall of the container.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

- 20 Referring to Figure 1, a substantially cylindrical plant growth container 1 is shown which incorporates an embodiment of the invention and which is of the general type disclosed by Australian patent application 51865/93. It is to be understood however, that the invention is not limited to use with the container as shown, but may be used with other tubular containers of generally cylindrical shape. The size of the containers is not critical.
25 However, preferred containers have diameters in the range 300mm to 600mm. The air pruning holes in the side wall are shown as being circular. However, these may also be elongated slots or any other shape that results in adequate air pruning of the root structure.

- The container 1 as shown includes a circular base 2, which can be attached to the container side wall 3 in any appropriate fashion. In the arrangement shown, the base 2 is
30 located within the tubular section of the container 1 so as to be surrounded by the side wall 3, and is retained in position by cooperation with that side wall as hereinafter described. The side wall 3 is preferably formed from a sheet of flexible cusped material which may be the

same as or similar to the material described in patent 629067, so that the inner surface of that wall has a lattice of inwardly projecting hollow cones or cusps 4 (as seen in Figure 2), and lattice of root guiding recesses 5 formed between the cones or cusps 4. The peripheral edge portion 6 of the base 2, or at least part of that edge portion, is positioned within one such 5 recess 5, and the recess 5 may be selected so that the base 2 is elevated above the lower edge 7 of the side wall. The base 2 is thereby supported by the cones or cusps 4 of the lattice row which defines the lower boundary of the recess 5 in which the base edge portion 6 is located. A cylindrical shaped supporting member may also be used.

Elevation of the base 2 enables an air gap 8 to be provided within the confines of the 10 container 1 below that base 2. Assuming an air gap is required below the base 2 it need not be provided in the foregoing manner, and consequently the base 2 can be located, if desired, at the extreme lower edge 7 of the side wall 3.

In the arrangement shown the overlapping edge portions 9 and 10 (Figure 1) of the side wall 3 are held together by at least one, but preferably two or more, screw threaded 15 fasteners 11. As is shown in Figure 2, the side wall 3 has outwardly projecting hollow cusps 12 which form the recesses 5 on the inner surface of the side wall 3 and which are the same or similar shape to the inwardly projecting cusps 4. An opening 13 is formed through the outer end of at least some of the outwardly projecting cusps 12, and such an opening is preferably provided in each cusp 12. The openings 13 enable air pruning of laterally 20 extending roots in a known manner, but in the arrangement shown by Figures 3 and 4 they also provide a convenient location for the fasteners 11.

As shown by Figure 4, the outwardly projecting cusps 12 of the inner edge portion 10 are located within the inner surface recesses 5 formed by the outwardly projecting cusps 12 of the outer edge portion 9 at the overlap. A threaded fastener 11 located within the aligned 25 openings 13 of two nested cusps 12 is therefore able to hold those cusps against separation and thereby hold the overlapping edge portions 9 and 10 against separation. For that purpose, as shown in Figure 4, the threaded fastener 11 preferably has an enlarged head 14 which can bear against the outer end surface of the outermost of the two nested cusps 12, and a thread convolution 15' of the fastener 11 bears against the inner surface of the innermost of the two 30 nested cusps 12. Two overlapping layers of the side wall 3 are thereby retained between the fastener head 14 and the thread convolution 15. It will be appreciated that because of the wall thickness of the sheet material and the extrusion process preferably used to prepare the

wall material that the cusp to cusp fit of protrusions is not very close. Indeed, when overlapping portions of the sheet material are fitted in a cusp to cusp position there may be gap of 5mm or more between the overlapping sheets. With releasable fasteners such as the wire slides used on prior art containers there is insufficient radial pressure to urge the overlapping sheets closer together than the above gap. It will be appreciated that the strength of the container relies on the closeness of the cusp to cusp fitment and the forces required to cause separation. Failure occurs when the gap increases such that relative circumferential movement between the overlapping edge portions of the side sheets is possible. The screws of the present invention urge the overlapping sheets together at the cusps. The helical thread of the screw draws the inner sheet towards the outer sheet on which the head of the screw is retained. Some deformation of the plastic wall material occurs in practice, both on the inner and outer sheet, as the two sheets are compressed together where the screw is located. This ensures very secure and close cusp to cusp mating and hence high strength containers. The wash out feature prevents overtightening. Normally a wash out feature suffers from the disadvantage that the attachment can not be easily released by reversing the rotation of the screw. However, in the overlap of containers as described above, there are sufficiently strong radial forces the screw has compressed the sheets together for the screw to be surprisingly releasable. This is clearly an important feature in the practical use of the present invention where release of the fastener is required before transplantation.

Normally screws are used for attaching a material to a substrate such as a hinge to a timber door. A screw is normally tapered and functions by drawing the head of the screw towards the substrate as it is rotated thereby securely anchoring and locating the hinge on the door. In a further application a screw may be used as a self tapping screw where a female thread is tapped into the lower of two sheets by the screw thread. In such an application the pitch of the helical thread is obviously less than the thickness of the lower sheet material. Neither of the two known uses of screws is similar to the application described above in the present invention. In the present invention the pitch of the helical thread accommodates at least two thicknesses of the sheet material forming the side walls. These screw fasteners are also clearly different from threaded fasteners intended for use with nuts.

A particularly satisfactory fastener 11 is shown by Figure 5, and includes an elongate shank 16 having an enlarged head 14 at one end and a helical thread 15 extending along part of its length. The pitch of the thread is 6mm. The diameter of the shank is approximately

6mm and this allows the fastener to be easily used in the air pruning holes. However it is not necessary for the air pruning holes to be circular and the fastener is also effective in elongate air pruning holes. Even when the width of the elongate slot is less than the diameter of the shank the screws may be used effectively. This appears to function by the screw forcing the slot to a width sufficient to accommodate the shank. An elongate slot of 3mm width appears to be adequate to accommodate a screw which has a shank of 6mm diameter. The thread 15 preferably has a relatively large depth between the crest and the base to enable secure retention against the innermost surface of the overlapping edge portions 9 and 10. The fastener illustrated has a radial distance between the crest of the thread and the shank of 3mm. It is further preferred that the thread convolution 15' adjacent the fastener head 14 terminates short of the head 14 so that a gap 16' (Figure 5) exists between the thread convolution 15' and the head 14. The gap 16' is preferably such as to accommodate two layers of the side wall material through which the fastener 11 passes and in the screw shown this distance is about 3mm. Such an arrangement avoids or at least minimises damage to the side wall material by the mechanism known as "thread stripping" which would otherwise be expected if the fastener 11 was rotated to an excessive extent. The use of such a fastener therefore enables rapid releasable fastening of the edge portions 9 and 10 with minimal risk of loss of fastening integrity.

The Wallmate (trade mark) fastener manufactured by I.T.W. New Zealand Ltd is one commercially available fastener which has been found suitable for the foregoing purpose. However the present application is far removed from the intended application of this commercial screw. The Wallmate screw is intended to be used to form an anchor point in plaster board walls and the wash out feature is to allow a string or cord to be located on that part of the screw standing proud of the surface without the helical thread causing damage to the string or cord.

In an alternative embodiment (not shown), the plant growth container is formed from two or more sheets of flexible cusped material, secured together with a first edge portion of one sheet overlapping a second edge portion of another sheet with the cusps of the outer surface of the second edge portion resting within the recesses of the inner surface of the first edge portion and the overlapping edge portions secured together by threaded fasteners in similar manner to that described with reference to Figures 3 to 5. For example, two sheets of flexible cusped material may be bent into substantially semi-circular form and fastened

together at diametrically opposed locations by two or more screws in the manner described above.

Containers of the foregoing kind are commonly lifted by grasping the upper edge 17, which has little resistance to distortion because of the relatively flimsy nature of the material from which the side wall 3 is constructed. In order to alleviate that problem the container 1 may be provided with a handle 18 (Figure 6), or preferably two handles 18 located at diametrically opposite sides of the container 1 adjacent the upper edge 17. In the example shown, each such handle 18 includes a relatively rigid tubular member 19 attached to the side wall 3 by a section of rope 20 or other flexible material which extends axially through the member 19 and passes through two of the side wall openings 13 for attachment to the side wall 3. Handles such as type BRH 102 manufactured by Rope and Plastic Products Pty Ltd have been found suitable for the foregoing purpose. Other arrangements that function in a similar manner may also be adopted.

It is also preferred to strengthen the upper edge portion of the container 1 by location of a relatively rigid ring or hoop 21 (Figure 2) within a recess 5 adjacent the upper edge 17 of the side wall 3. The hoop 21 may be constructed of tubular material such as that used for irrigation pipes, in which case the tubular hoop 21 may be provided with an inlet 22 and at least one outlet 23 for ingress and egress of water. Such an arrangement has the dual function of strengthening the upper edge of the container 1 and providing a convenient means of watering the contents of the container. The hoop 21 also provides an alternative to the handles 18 for gripping and lifting or moving the container 1.

The container base 2 can be of any suitable construction, but it is preferred to have a perforated base so as to enable air pruning of downwardly extending roots. One example form of base 2 is shown by Figures 2 and 7. That base 2 has a series of openings 24 each of which progressively reduces in cross sectional size from the upper surface 25 of the base 2 to the lower surface 26 thereof.

Figure 8 is a cross sectional view of another form of base 2 having an annular foot 27 connected to the body 28 of the base 2 through a web 29. The annular foot 27 may be formed integrally with the web 29, or it may comprise an annular ring secured to the base 2, for instance by screws or other fastening means. At least one opening 30 is formed through the web 29 to allow air to pass through the space below the base body 28 when the foot 27 is engaging the ground or another supporting surface. The arrangement is such that

the base body 28 can be located close to the lower edge 7 of the side wall 3 whilst still retaining the facility to air prune at the base. The construction shown by Figure 8 can be varied in a number of ways. For example, as shown by Figure 9, the foot 27 and the connecting web 29 may be discontinuous rather than continuous as shown in Figure 8, and a space 30 formed between adjacent parts of the web 29 provides the openings for air circulation below the body 28 of the base 2.

The base 2 shown by Figure 9 also differs from that shown by Figure 8 in that an inverted cone 31 extends downwardly from the center of the base body 28. The cone 31 is preferably hollow as shown and may have an opening 32 at its lower end to permit passage of water. As well as cone 31 a cylindrical member can be used. The axial length of the cone 31 is preferably such that it provides a support for the center of the base 2 to prevent sagging at the center when the base 2 is subjected to a heavy load.

Figure 10 shows another arrangement which may be adopted, particularly for a large diameter base 2, in which a row of supporting cones 31 is arranged across the diameter. The base 2 may be provided with two or more such rows of cones 31, and that those rows could be arranged substantially parallel or in a suitable angular relationship.

A base of the kind shown by any one of Figures 8 to 10 can be used for flood and drain watering or for capillary watering. The former arrangement is shown by each of Figures 8 to 10. If the container 1 is to be used with capillary watering the base 2 of each of Figures 8 to 10 can be mounted on the container with the body 28 lowermost and the foot 27 located within the side wall recess 5. The perforated body 28 can then be placed on a moistened mat or the like which provides the moisture source for capillary watering.

It is preferred that containers comprise two or more sheets of material. Sheet material manufactured by a continuous extrusion process has the positioning of the protrusions varying. This means that the cusp to cusp securing method results in a diameter that is either too great for the base if the positioning is greater than specification or too small if the positioning is less than specification. The effect of this variation is exacerbated in larger pot diameters, especially those above 400mm and it is with these larger pots where this feature is preferred.

The above problem can be alleviated by using at least two sheets to form the side wall. By using at least two sheets, a matching of panels with over and under specification

cusps spacing can take place allowing containers of the desired diameter to be assembled. Although using two panels instead of one requires twice as many fasteners and a further overlap of sheet material the ease of assembly outweighs these problems.

It is preferred to form the openings 13 and the side wall 3 by a punching process, and one particularly satisfactory process is described below. As previously stated, the side wall 3 is preferably formed of a single sheet of material of appropriate length and width. In the process hereinafter described such a sheet of material is fed through a punching station while in a flat or substantially flat condition. A plurality of such sheets could be fed in succession through the punching station in a continuous process.

Figure 11 is a diagrammatic illustration showing a sheet 33 of side wall material being fed through a punching station 34 while being supported on a table 35.

The punch 36 shown by Figure 11 is preferably one of a series of punches extending across the complete width of the sheet 33 to be punched (see Figure 14). Figure 12 is an enlarged view of a punch 36 of preferred construction in which the operative end 37 is preferably concave so as to be of substantially C shape as distinct from spherical. Such an arrangement has been found satisfactory for the purpose of producing an opening 13 of accurate size and shape with minimum effort.

It is preferred to provide appropriate locating means on at least one punch 36 of the series of punches so as to accurately position the sheet 33 prior to penetration by the punch 36. In the example illustrated in Figure 12 the locating means includes a member 38 of suitable shape, such as frustoconical, which is slidably mounted on the punch body and which is shaped and dimensioned to locate within the hollow interior of a cusp 12. The member 38 may be biased towards the punch end 37 by a spring 39 or other suitable means, and any appropriate method may be adopted to limit the extent to which the member 38 can move towards the punch end 37.

The sheet 33 is preferably fed through the station 34 in a stepwise fashion. That is, movement of the sheet 33 in the direction of arrow A (Figure 11) is halted when a row of cusps 12 is positioned below the series of punches 36, and the sheet 33 remains stationary during formation of the holes 13 in that row of cusps 12. The necessary stepwise movement can be achieved in any suitable fashion. Figure 13 is a diagrammatic illustration of one particular sheet drive system which involves use of an escapement wheel 40 having a plurality of fingers 41 projecting radially therefrom in evenly spaced relationship about the

wheel circumference. The fingers 41 project through an opening 42 formed in the table 35 so as to be engageable with an appropriate part of the sheet 33, such as the cusps 12, as shown by Figure 13.

Any suitable mechanism may be adopted to drive the wheel 40 in the direction of
5 arrow B in a stepwise fashion. By way of example, that mechanism may include a ratchet system, part of which rotates continuously and which is arranged so that the wheel 40 is positively driven in the direction of arrow B during each of a number of phases of the rotational movement of the rotating part. The wheel 40 remains stationary between each of those phases, and it is at that time that the punches 36 are operated to form the holes 13.

10 Control means of any suitable kind can be employed to synchronise rotation of the escapement wheel 40 with operation of the punches 36.

In the example of the arrangement shown, the series of punches 36 is carried by a punch head member 43 which is guided for movement towards and away from the table 35 by any suitable guide means 44 (Figure 11). Any suitable drive system may be employed to
15 drive the head member 43 up and down. By way of example, the drive system may include a crank arm 45 pivotally connected at opposite ends to the member 43 and a crank wheel 44 respectively (Figure 14). Rotation of the crank wheel 44 may be synchronised with rotation of the escapement wheel 40 in any suitable manner.

It is preferred that the punches 36 in the series of punches are relatively
20 arranged so that not all punches 36 penetrate the sheet 33 at the same time. If desired, the arrangement may be such that only one punch 36 penetrates the sheet 33 at any one moment in time. Figure 14 shows an arrangement in which the punches 36 are arranged in three groups 47, 48 and 49, and there are three punches in each group. A larger or smaller number of groups could be adopted and the number of punches in each group could be more or less
25 than that shown. In the arrangement shown, the punches 36 of the group 47 lead the other two groups and are therefore the first to penetrate the sheet 33, and the punches 36 of the group 48 lead the third group 49 as to be the second group to penetrate the sheet 33. Such an arrangement minimises the force necessary to complete the punching of a row of cusps 12.

Other arrangements could be adopted to achieve the same result.

30 Figure 11 indicates that only one row of cusps 12 is punched during each punching operation. The punch head could be constructed so that two or more rows are punched at the same time.

It will be apparent from the foregoing description that the present invention provides an improved plant growth container and also provides an improved method and apparatus for constructing the material used to form the side wall of such a container.

Finally, it is to be understood that various alterations, modifications and/or additions
5 may be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention.

Claims:

1. A plant growth container including at least one sheet of flexible material having opposite first and second edge portions, an inner surface and an outer surface, said inner surface having a lattice of root guiding recesses formed therein, at least some of said recesses
5 being of substantially truncated conical form terminating in an opening through the sheet, said outer surface having a lattice of protuberances at the same relative positional arrangement as the recesses, said sheet being arranged with a first edge portion overlapping either an opposite, second edge portion of the same sheet or a second edge portion of another similar sheet, with the protuberances of the outer surface of the second edge portion nesting
10 within the recesses on the inner surface of said first edge portion to align openings in the protuberances at the overlap and wherein at least one screw threaded fastener having a threaded shank and an enlarged head at one end of that shank, is located within the aligned openings to secure the overlapping edge portions together.
- 15 2. A plant growth container as defined in claim 1 wherein the screw threaded fastener has a pitch greater than the thickness of the sheet material.
3. A plant growth container as defined in claim 2 wherein the screw threaded fastener
20 has a gap between the head of the screw and the thread convolution closest to the head of at least two thicknesses of sheet material.
4. A plant growth container as defined in any one of claims 1 to 3 which further includes a base formed of a perforated material adapted to promote air pruning of downwardly
25 extending roots and wherein the base is adapted to be retained between two rows of inwardly protruding cusps in a container.
5. A plant growth container as defined in claim 4 wherein the base includes a foot portion for ground engagement in use and wherein the base is adapted to provide flood and
30 drain watering as well as capillary watering.
6. A plant growth container as defined in claim 4 or 5 which has two sheets of flexible

material as the wall material.

7. A plant growth container as defined in any one of claims 1 to 6 wherein the sheet or sheets of flexible material are manufactured by an extrusion process.

5

8. A plant growth container as defined in claim 7 wherein the openings in the cusps are formed by a punching process of openings in sequence by feeding the sheet material to be punched through a punching station in step wise fashion such that a respective group of openings is formed each time the material pauses at the punching station.

10

9. A plant growth container base as defined in claims 4 or 5.

15

1 / 4

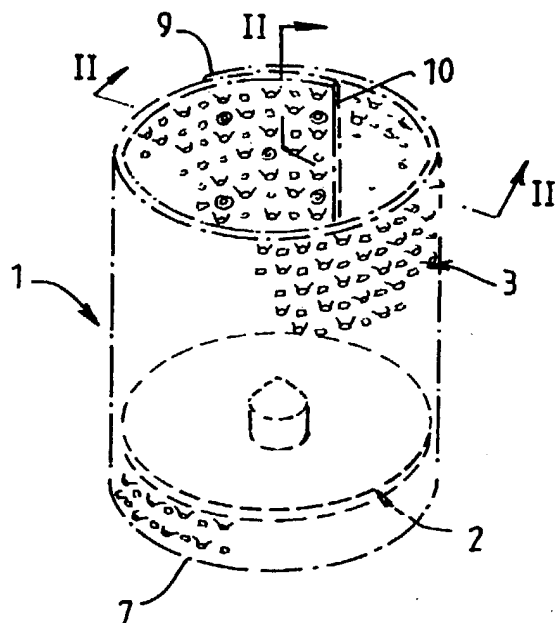


FIG. 1.

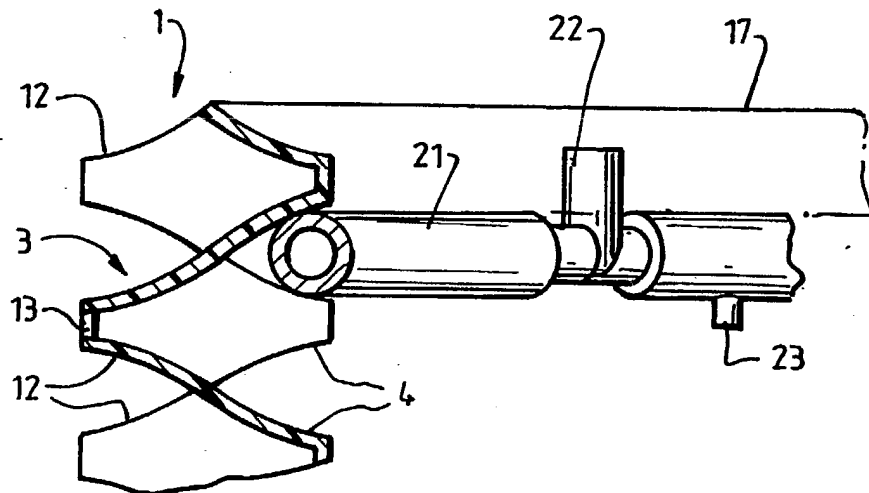
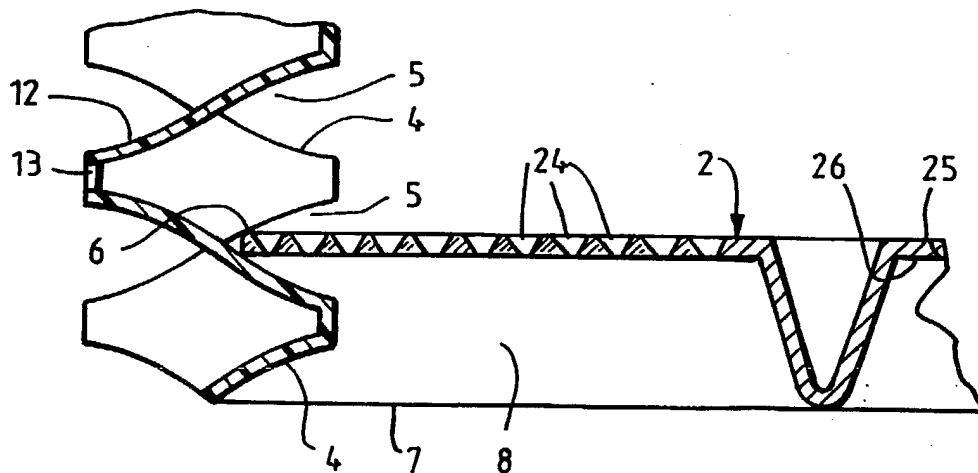


FIG. 2.



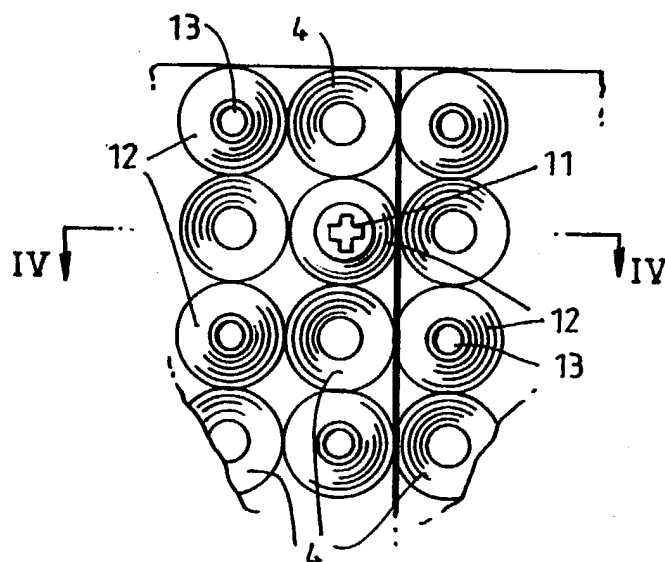


FIG. 3.

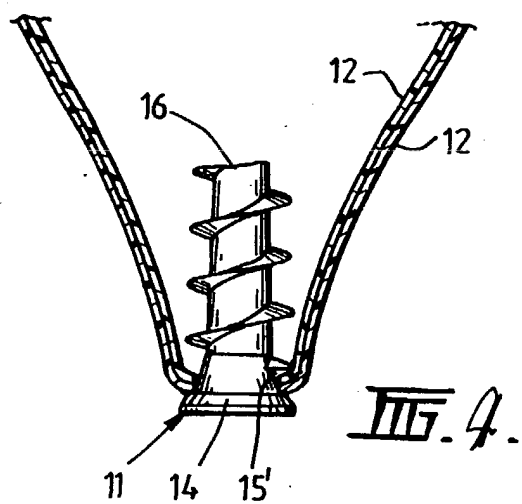


FIG. 4.

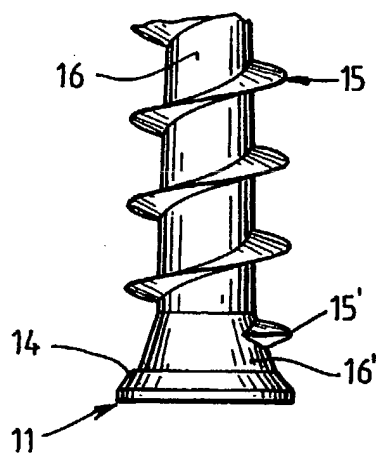


FIG. 5.

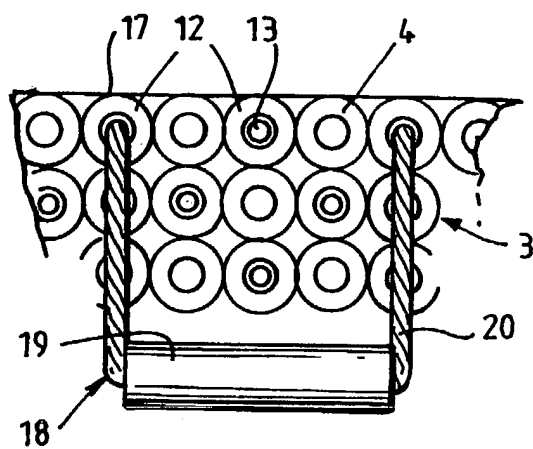


FIG. 6.

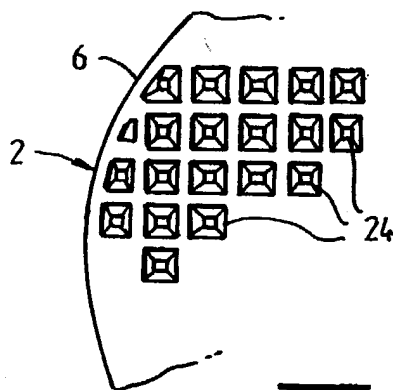


FIG. 7.

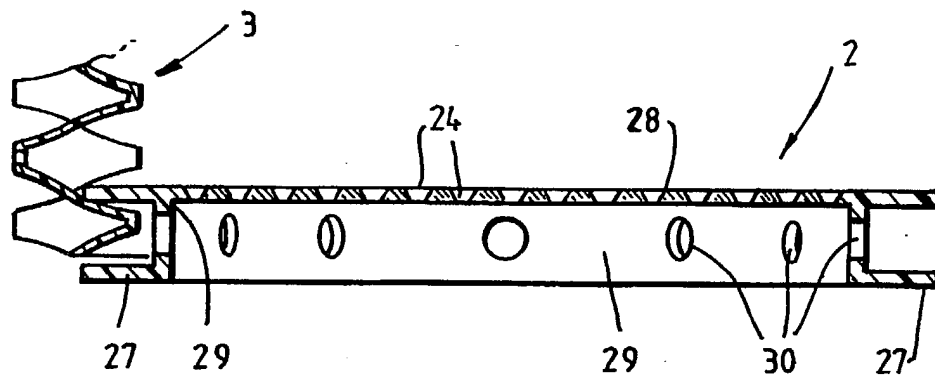


FIG. 8.

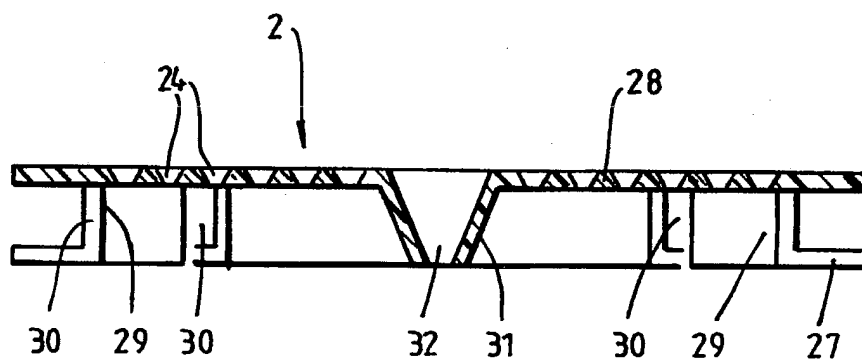


FIG. 9.

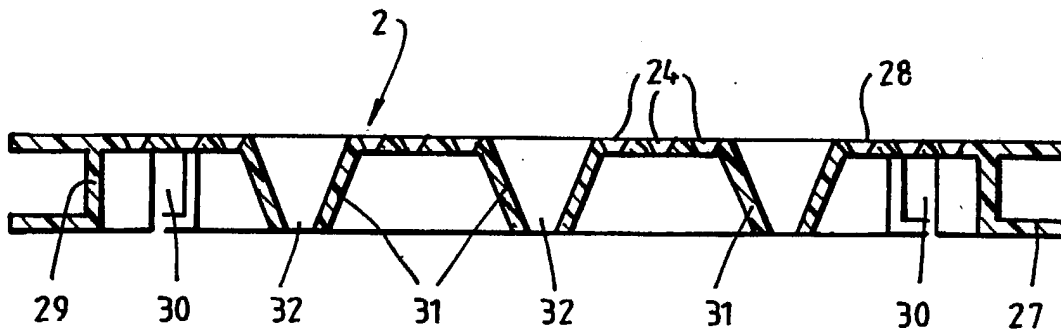
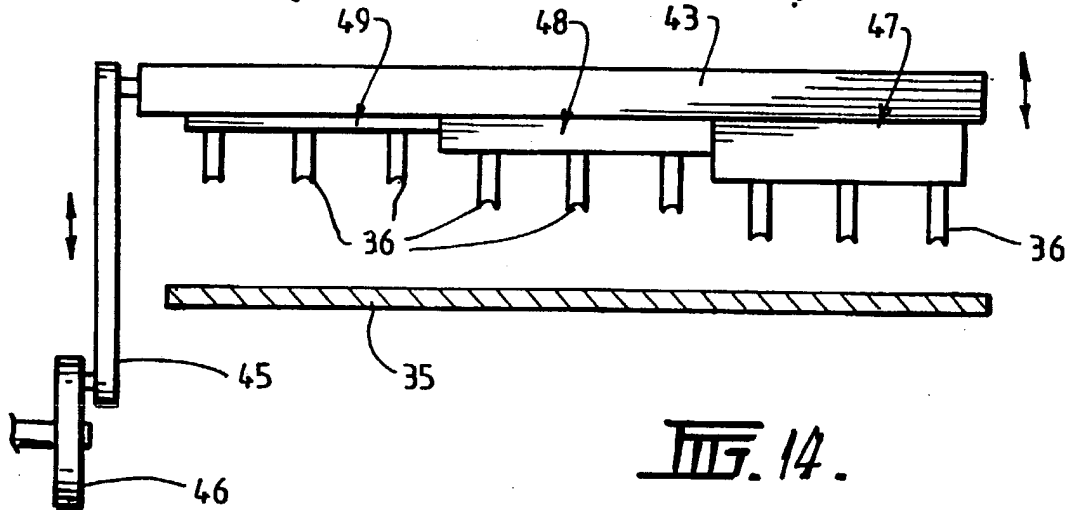
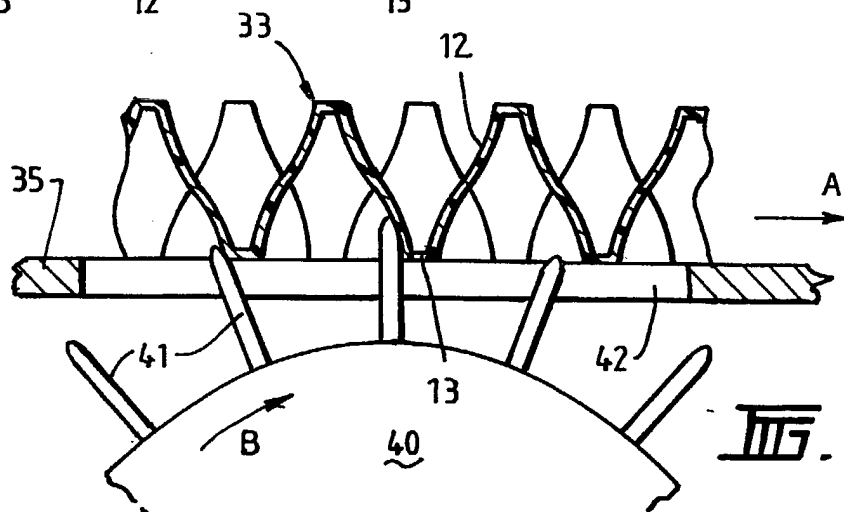
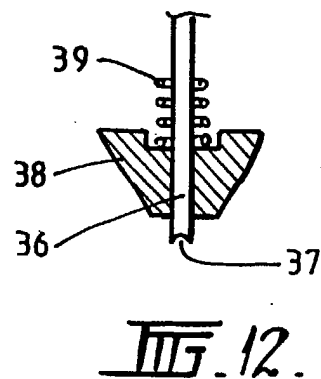
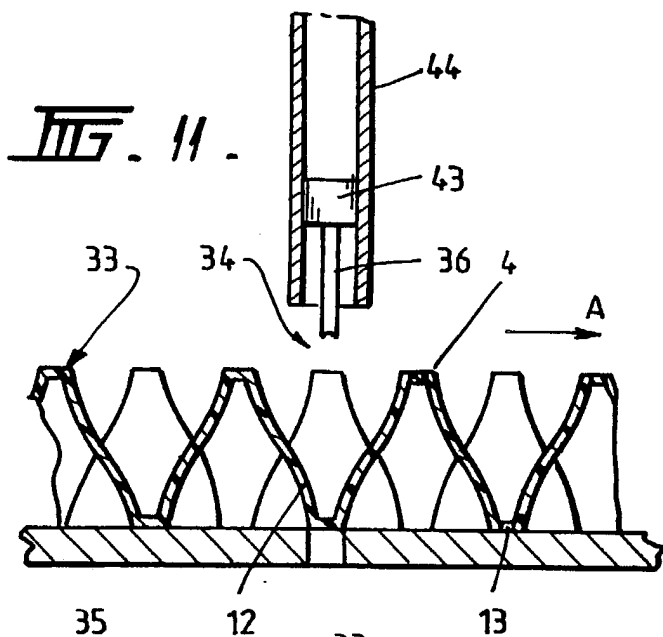


FIG. 10.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 98/00804

A. CLASSIFICATION OF SUBJECT MATTER												
Int Cl ⁶ : A01G 9/02, 9/10												
According to International Patent Classification (IPC) or to both national classification and IPC												
B. FIELDS SEARCHED												
Minimum documentation searched (classification system followed by classification symbols) A01G 9/02, 9/10												
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU : A01G 9/02, 9/10												
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DERWENT												
C. DOCUMENTS CONSIDERED TO BE RELEVANT												
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.										
X	AU 51865/93 (674543) B (RONNEBY TREE FARM) 9 June 1994 Entire document	1-4, 6-8										
X	AU 66674/90 (629067) B (RONNEBY TREE FARM) 23 May 1991 Entire document	1-3, 7, 8										
X	AU 59923/96 A (LAWTON) 15 January 1997 Entire document	1-8										
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex												
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td>"&" document member of the same patent family</td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	"P" document published prior to the international filing date but later than the priority date claimed	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention											
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone											
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art											
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family											
"P" document published prior to the international filing date but later than the priority date claimed												
Date of the actual completion of the international search 15 October 1998		Date of mailing of the international search report 23 OCT 1998										
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929		Authorized officer A. SEN Telephone No.: (02) 6283 2158										

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 98/00804

Box 1 Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claim No.: 9
because its scope cannot be determined since it defines a 'plant growth container base' which is simply a component of the 'plant growth container' defined in Claims 4 and 5 to which it is appended
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.